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BIOLOGY OF A PINE NEEDLE SHEATH MIDGE, *CONTARINIA ACUTA* GAGNÉ (DIPTERA: CECIDOMYIIDAE), ON LOBLOLLY PINE

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Abstract.—The biology of a pine needle sheath midge, *Contarinia acuta* Gagné is described for a new host in Louisiana. This midge was found feeding within the needle sheath on elongating needles of loblolly pine, *P. taeda* L. Needle droop and partial defoliation were evident on heavily infested trees. Overwintering *C. acuta* adults were first detected emerging from the soil on April 30, 1984. The population progressed through four generations between May 11 and September 17, 1984.

Key Words: *Contarinia* sp., pine needle sheath midge, pine seed orchards, loblolly pine

Two species of *Contarinia* are known to cause needle droop on pines in North America. One, the introduced *Contarinia baeri* (Prell), is found on Scots pine, *Pinus sylvestris* L., and on red pine, *P. resinosa* Ait., in northeastern North America. It was first discovered in Europe in 1930 (Skuhravý 1973) and later reported on Scots pine in Canada (DeBoo et al. 1973, Wilson et al. 1988). The second species, *Contarinia acuta* Gagné, is found on slash pine, *P. elliottii* Engelmann, in southeastern United States. Gagné and Beavers (1984) reported on *C. acuta* and three other *Contarinia* species. The last three were recovered from pitfall traps only, so their role on slash pine is unknown.

Contarinia acuta was found in 1971 to cause needle droop and defoliation on loblolly pine at the Erambert Seed Orchard in Brooklyn, Mississippi (Overgaard et al. 1976). Populations continued to build until 1975 when the population collapsed (Overgaard et al. 1976). An evaluation conducted from March to September 1975 detected three major larval population peaks: the first peak in May, the second peak beginning in late June, and the third peak beginning in mid-to-late July (Overgaard et al. 1976). Similar damage was reported in 1975 from an orchard in McNair, Mississippi (Overgaard et al. 1976). The next documented report of an outbreak of this species occurred in 1983 at the Stuart Seed Orchard in Pollock, Louisiana (Weatherby et al. 1983). During this outbreak, only loblolly pines were infested, while slash, longleaf, and shortleaf pines remained unaffected. This paper reports on the biology of *C. acuta* infesting loblolly pine in central Louisiana.

Materials and Methods

Larval sampling procedures. Field studies were conducted at the Stuart Seed Orchard. In 1983, actively growing shoots from susceptible clones were sampled. Clones 5, 18, 20, 30, and 43 were selected from clones in the Texas loblolly seed source. One ramet of each clone was randomly selected on August 23. Five shoots of new growth were clipped from each ramet and 25 fascicles were randomly selected from each shoot. The fascicle sheath was removed and the number of larvae per fascicle recorded. On August 31, four different ramets of three of the five original clones were randomly selected and sampled. Five shoots of new growth were selected and five fascicles per shoot were removed for examination from each of the sample ramets. The number of larvae per fascicle was recorded. A final examination was conducted on October 19.

In 1984, sample trees were randomly selected from a 52-acre block of mature loblolly trees grafted from Louisiana seed sources. Larval development was monitored by sampling fascicles from sample branches. After needle elongation began in the spring, two sample branches were removed from the upper portion of the canopy and one sample branch was removed from the middle portion of each sample tree. A total of 12 trees were sampled every 2 weeks from April 13 through August 28. Sample branches from each tree were placed in a plastic bag and transported back to the laboratory. Five fascicles were removed from the last growth flush on each branch, the needle sheaths were removed, and the needles were inspected under a dissecting microscope. The numbers of first instar, second instar, and third instar larvae per fascicle were recorded. During periods when multiple growth flushes and overlapping generations coincided, five fascicles were removed from each of the last two growth flushes on each sample branch. Larval densities were determined for each instar on the last two growth flushes.

Prepupal sampling procedures. Prepupal migration from trees to pupation sites in the soil was monitored with sticky traps. Plywood squares, 0.30 m by 0.30 m, were covered with white freezer paper and sprayed with Tree Tanglefoot (Tanglefoot Company, Grand Rapids, MI). These squares were mounted horizontally on top of 0.91 m stakes. Five sample trees were randomly selected and four traps, one at each cardinal point, were placed under the dripline of each tree. Prepupal traps were installed on May 25 and monitored through September 17, 1984. Traps were inspected weekly and larvae were counted and removed.

Adult sampling procedures. Adult flights were monitored by using adult emergence traps. Traps were constructed from 11.36 l plastic wash tubs and 0.24 l glass jars. The mouth of a jar was inserted into a hole on the side of the tub and secured with a fitting that was attached to the exterior side of each tub approximately 2.54 cm above the bottom. Each tub was inverted and one trap was placed under the dripline of each sample tree. A total of five traps were placed in the Louisiana loblolly seed source. The emergence traps were installed on March 10, 1984, and the jars were inspected weekly for emerging adults. Adult midges were removed from each trap and placed in vials containing 70 percent ethanol. These vials were forwarded to RJG for identification. The traps were relocated after the prepupal migration of each generation in order to capture adults. Adult trapping was terminated on September 17.

Results and Discussion

In 1983, the mean larval density on clones 5, 18, 20, 30, and 43 was 14.48 larvae per fascicle on August 23. Populations decreased dramatically by August 31 to 2.51 larvae per fascicle and no larvae were detected on October 19, indicating that the late August generation was the overwintering generation (Table 1).

Population sampling conducted in 1984

Table 1. Comparison of mean larval densities recorded on the last three sampling dates at the U.S. Forest Service Stuart Seed Orchard, Pollock, LA (1983).

Clone	Mean Number of Larvae per Fascicle		
	Aug. 23	Aug. 31	Oct. 19
5	11.14	—[a]	—
18	17.82	2.48	0.00
20	17.64	—	—
30	14.09	1.43	0.00
43	11.72	3.61	0.00
Mean	14.48	2.51	0.00

[a] — Indicates that samples were not taken.

showed that the population progressed through four generations between April 30 and September 17. Adult emergence of the 1983 overwintering generation was detected on April 30 and continued through May 18. The second, third, and fourth adult flights occurred between June 4 and June 18, June 25 and July 18, and August 8 and August 27, respectively.

Adult emergence from overwintering sites, oviposition, and egg hatch of the first generation coincided with the beginning of needle elongation on the first growth flush of the trees in the Louisiana loblolly seed source. During subsequent flight periods, females preferentially oviposited on the most recent foliage. First and second generation larvae primarily infested the first growth flush. Third generation larvae infested both second and third growth flushes. The last or fourth generation larvae were found within the fascicles of the fourth growth flush.

Mean larval densities per fascicle of first, second, and third instars for each sample date are listed in Table 2. These densities were considerably less than those recorded for the final generation in 1983. The presence of first instar larvae were first detected on May 11. Three additional population peaks occurred on June 11, July 13, and August 10. Similar peaks in larval density were detected for second instars. Considerable reduction occurred in the population densities between second and third instars

Table 2. Means of larval population densities obtained from branch samples taken from loblolly pines in the Louisiana seed source at the U.S. Forest Service Stuart Seed Orchard, Pollock, LA (1984).

Date	Growth Flush	# Fasc.	Number of Larvae/Fascicle		
			1st Instar ♀	2nd Instar ♂	3rd Instar ♂
April					
13	1st	225	0.00	0.00	0.00
30	1st	180	0.00	0.00	0.00
May					
11	1st	180	0.19	0.00	0.00
17	1st	750	0.11	0.19	0.11
31	1st	180	0.18	0.00	0.00
June					
11	1st	180	0.35	0.00	0.01
	2nd	120	0.10	0.00	0.01
18	1st	180	0.25	0.29	0.11
	2nd	145	0.03	0.04	0.02
26	1st	175	0.07	0.08	0.10
	2nd	170	0.05	0.06	0.02
July					
13	2nd	155	0.66	0.09	0.04
	3rd	170	1.30	0.09	0.00
20	2nd	180	0.09	0.16	0.00
	3rd	180	0.45	0.74	0.03
27	3rd	180	0.02	0.02	0.17
August					
10	3rd	170	0.06	0.04	0.05
	4th	70	0.99	0.11	0.14
28	3rd	150	0.19	0.15	0.03
	4th	15	0.93	1.27	0.07

(Table 2). This reduction could have been a real decrease attributed to natural mortality, or it could have been a result of poor synchronization between sampling frequency and phenology of each generation.

Third instar larvae developed to the prepupal stage within the fascicle sheath. Prior to pupation, prepupae left the sheath and fell to the ground. Pupation occurred in the ground litter under the canopy. Peak migrations to the ground of the first, second, and third generation prepupae were detected on May 29, June 27, and August 6 (1984), respectively (Table 3). A fourth generation prepupal peak was barely detectable due to a rapid collapse in the population.

Table 3. Mean number of prepupae captured on 1 sq. ft. sticky traps located under the dripline of loblolly pines in the Louisiana seed source at the U.S. Forest Service Stuart Seed Orchard, Pollock, LA (1984).

Date	Mean Number of Prepupae per 1 Sq. Ft.	Date	Mean Number of Prepupae per 1 Sq. Ft.
May 29	4.10	July 16	0.20
31	0.20	18	0.00
June 4	0.50	20	0.00
6	0.05	25	0.10
8	0.05	27	0.20
11	0.25	August 3	0.15
13	0.00	6	2.70
15	0.15	8	0.10
18	0.10	10	1.40
20	1.00	13	0.00
22	0.40	17	0.00
25	1.65	22	0.00
27	11.25	24	0.00
30	6.55	28	0.00
July 2	0.40	September 4	0.20
4	0.20	6	0.05
6	0.30	10	0.00
9	0.60	12	0.00
11	0.05	17	0.00
13	0.15		

During the 1984 outbreak, larval mortality between the second stadium and the prepupal stage of the fourth generation was high. Increasing populations of the natural enemies, particularly *Pyemotes emarginatus* Cross, Moser, and Rack, were observed during larval sampling. Cross, Moser, and Rack (1981) discuss the biology of this mite parasitoid that is known only from *C. acuta*. In addition, several predaceous larvae of *Lestodiplosis* (Cecidomyiidae) were found within the fascicle sheaths with *C. acuta* larvae.

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